Remarks

Applicant's representative again would like to express his appreciation for the courtesies extended by the Examiner during the interview held on October 16, 2008. During the interview, the claims as previously presented were discussed, and the undersigned reiterated the arguments previously presented in the last-filed appeal brief.

In addition, certain claim amendments were discussed, and the substance of those amendments is reflected in the foregoing amendments to the claims. Based on the remarks given in support of the prior rejections, the Examiner would have to find a reasonable basis to now add a third reference, even though it is submitted that there is no reasonable basis for the combinations of two references made in the last Office Action as discussed below.

Background

Shock absorbing devices are used in a wide variety of vehicle suspension systems for controlling motion of the vehicle and its tires with respect to the ground and for reducing transmission of transient forces from the ground to the vehicle. Shock absorbing struts are a common and necessary component in most aircraft landing gear assemblies. The shock struts used in the landing gear of aircraft generally are subject to more demanding performance requirements than most if not all ground vehicle shock absorbers. In particular, shock struts must control motion of the landing gear, and absorb and damp loads imposed on the gear during landing, taxiing and takeoff.
A shock strut generally accomplishes these functions by compressing a fluid within a sealed chamber formed by hollow telescoping cylinders. The fluid generally includes both a gas and a liquid, such as hydraulic fluid or oil. One type of shock strut generally utilizes an "air-over-oil" arrangement wherein a trapped volume of gas is compressed as the shock strut is axially compressed, and a volume of oil is metered through an orifice. The gas acts as an energy storage device, such as a spring, so that upon termination of a compressing force the shock strut returns to its original length. Shock struts also dissipate energy by passing the oil through the orifice so that as the shock absorber is compressed or extended, its rate of motion is limited by the damping action from the interaction of the orifice and the oil.

Over time the gas and/or oil may leak from the telescoping cylinders and cause a change in the performance characteristics of the strut. Presently, there is no reliable method of verifying the correct servicing parameters of aircraft shock struts. While gas pressure can be readily monitored, it cannot be readily determined if a loss in gas pressure arose from leakage of gas alone or from leakage of both gas and oil, unless external evidence of an oil leak is noticed by maintenance personnel. If a low pressure condition is detected in the absence of external evidence of an oil leak, maintenance personnel heretofore would restore the gas pressure to a prescribed level by adding gas. This, however, eventually leads to degraded performance of the shock strut if oil had indeed escaped from the strut. Even if evidence of a oil leak is observed, maintenance personnel cannot easily determine how much oil remains or whether the remaining amount of oil meets specifications or is acceptable for operation.

Two methods can be used to determine whether a strut has the correct pneumatic charge. One method is to jack-up the aircraft to take the weight off of the struts such that each strut is fully extended. The proper pressure that corresponds to the extended position of the strut is a known value. In the other method the pressure is measured with the aircraft supported by the strut using a pressure gauge, and the stroke is measured to determine the extension of the strut. Variations in the weight of the aircraft and the position of the center of gravity cause the strut to sit at a variety of strokes in this situation. A look-up table or chart is then used to verify that the stroke and the pressure match an acceptable value. Since jacking the aircraft is rarely done and is very time consuming, the method of verifying the pressure with the aircraft supported by the strut in a static position is most commonly used. This latter technique, however, is not a very reliable way to check the oil level.

The only reliable way to know that the oil level is acceptable is to vent the pneumatic charge and pump oil through the strut to ensure a proper oil level. The strut can then be re-inflated with gas to the proper pressure. This operation takes a significant amount of time, and as a result maintenance personnel may skip this step and only correct the pressure by adding or venting gas. In addition, neither technique enables detection of the oil level while the aircraft is in flight.

Still another technique is described in Labrecque which has been applied by the Examiner to reject the claims in the present application. Labrecque discloses an oil level indicator for use in a landing gear strut. The indicator of Labrecque is operated by over-displacement of the piston. The indicator includes a rod that extends through an

end wall of the strut's cylinder to provide a visual indication of excessive oil loss and a condition of potential danger.

Summary of the Claimed Subject Matter

With reference to the application drawings, a shock strut 10 according to the present invention that includes one or more probes 80/82 for detecting a condition of a liquid level in the strut through interaction with the liquid in the chamber 42. The shock strut may be an aircraft shock strut 10 forming part of an aircraft landing gear, which strut comprises a cylinder 32 and a piston 30. The piston 30 is telescopically movable within the cylinder and defines therein the sealed chamber 42 partially filled with a liquid and partially filled with a gas. Each probe preferably is a liquid level sensing fiber optic probe positioned for interaction with the liquid in the chamber, and a fiber optic cable 41 passes through a wall of the strut for connecting the probe or probes to a processor 39 for processing a signal from the probe related to the level of liquid in the chamber. At least two probes may be spaced apart along a longitudinal axis of the strut, such that a first one of the probes detects a condition of a first liquid level and a second one of which detects a condition of a second liquid level. The processor 39 may store probe data for retrieval by maintenance personnel and/or may provide an alert, such as illuminating a light in the cockpit to be observed by flight personnel and/or in the wheel well to be observed by the ground crew after the flight and/or before the next flight.

Thus maintenance personnel, or even a flight crew, can readily ascertain whether the liquid level in the strut is within acceptable parameters and can monitor the liquid level for leaks. Moreover, the sensor assembly enables this monitoring to be done in flight. In particular, personnel removed from the landing gear and the strut, such as a pilot, can check a condition of the liquid level, such as whether the level of liquid is below a specified minimum in the strut, either after takeoff and before the landing gear is retracted or after extending the strut for landing but before the aircraft touches down on the runway. At that point the strut is not under load and is fully extended, and reliable readings can be taken that will indicate whether the liquid level in the strut is acceptable. In addition or alternatively, the data may be stored for later retrieval by maintenance personnel.

The present invention also provides a sensor assembly 35 having such a probe or probes that can be removed from the strut as a unit, thereby facilitating repair and maintenance of the sensor assembly. The strut may also include a guide tube 74

mounted within the chamber so that the unit at least partially extends through and is located by the guide tube.

In addition, a fitting assembly 72 may be provided for sealing the cable to the wall of the strut through which the cable passes. The fitting assembly preferably includes a plug 98 molded around the cable 73 and a retainer 100 for holding the plug in sealed relationship with a through passage in the strut. The cable may include at least one optical fiber or a plurality of optical fibers 73 that have transversely spaced apart, coextending portions, each of which is surrounded in sealed relationship by the plug that has been molded thereto.

Rejection of Claims over *Labrecque* in view of *Spiteri*

Claims 2-5, 10, 11, 21 and 22 were rejected under 35 U.S.C. § 103(a) as being unpatentable over *Labrecque* in view of *Spiteri*. It is respectfully submitted that there is no reasonable basis for combining *Labrecque* and *Spiteri* in a manner that would give rise to an aircraft shock strut as claimed.

Labrecque does not disclose a "probe". The *Labrecque* indicator includes a rod 14 that extends through an end wall of the strut's cylinder to provide a visual indication of the quantity of oil in the strut at the location of the strut. When the oil supply in the strut has been depleted sufficiently to allow upper bearing 41 of piston 44 to contact the corresponding surface of cylinder 40, any further movement of the floating piston 43 in response to air pressure in chamber 47 will cause the piston to approach and thereafter contact the end of rod 14. Further movement of piston 43 toward upper bearing 41 will drive rod 14 through a rupturable disc 21, exposing a colored indicator 19 to view and alerting personnel to the condition of low oil supply well in advance of depletion of the supply to a damaging level. In the embodiment of Figs. 3 and 4, a depletion of the supply of oil will cause piston 53 to rise in the cylinder and the positive connection of rod 52 to piston 53 will drive colored indicator 54 at the upper end of rod 52 further out of cylinder 50 so as to become more visible as more of the rod 52 is exposed.

The foregoing operation of the indicator arises from the dynamic action of the strut. This dynamic response enables a visual indication of the position of floating piston 53 also enables personnel to correlate the piston 53 position with the landing gear position. See *Labrecque* at column 2, lines 66-68.

The modification advanced by the Examiner would negate this indication of the correlation of the piston 53 position with the landing gear position. *Spiteri* discloses an engine oil level sensor in completely different environment. *Labrecque* discloses an indicator that responds to the dynamic operation of the shock strut, whereas *Spiteri* is concerned with measuring the level of oil in an engine crankcase without any reliance on the dynamic action of the engine. A shock absorber and more particularly an aircraft shock strut is a dynamic device including relatively moving parts that interact with a gas and liquid contained in a dynamically changing and sealed chamber to perform a shock absorbing or dampening function. It is respectfully submitted that the skilled person would not have looked to *Spiteri* for improvements to the shock strut of *Labrecque*. In addition, the use of the *Spiteri* probe arrangement would not provide the same indication as that provided by the indicator of *Labrecque*, that being a correlation between the piston 53 position with the landing gear position.

As amended, claim 2 now requires a plurality of optical liquid sensing probes spaced apart along a longitudinal axis of the strut. Neither *Labrecque* nor *Spiteri* disclose a plurality of liquid sensing probes and much a plurality of liquid sensing probes spaced along a longitudinal axis of a strut.

Robinson was used to reject claims calling for a plurality of liquid sensing probes, but *Robinson* discloses a liquid level sensor for a liquid tank. *Robinson* has nothing to do with a shock absorber and much less an aircraft shock strut. A shock absorber and more particularly an aircraft shock strut is a dynamic device including relatively moving parts that interact with a gas and liquid contained in a dynamically changing and sealed chamber to perform a shock absorbing or dampening function. In contrast, *Robinson* is used to indicate the level of a liquid in a tank that does not dynamically change in configuration during use, and there is lacking any suggestion or hint of using the devices or features of Robinson in a shock absorber and much less in an aircraft shock strut.

The above-noted distinction is more than an insignificant difference. Only *Labrecque* discloses an oil level indicator for use in a landing gear strut. The indicator of *Labrecque* is operated by over-displacement of the piston. The indicator includes a rod 14 that extends through an end wall of the strut's cylinder to provide a visual indication of the quantity of oil in the strut. Thus, there is absolutely no need for arrangements like those shown in *Spiteri* and *Robinson*.

Rejection of claims over *Labrecque* in view of *Robinson*

As above noted, *Robinson* discloses a liquid level sensor for a liquid tank. *Robinson* has nothing to do with a shock absorber and much less an aircraft shock strut. A shock absorber and more particularly an aircraft shock strut is a dynamic device including relatively moving parts which interact with a gas and liquid contained in a dynamically changing and sealed chamber to perform a shock absorbing or dampening function. In contrast, *Robinson* is used to indicate the level of a liquid in a tank that does not dynamically change in configuration during use, and there is lacking any suggestion or hint of using the devices or features of *Robinson* in a shock absorber and much less in an aircraft shock strut.

The above-noted distinction is more than an insignificant difference. Only *Labrecque* discloses an oil level indicator for use in a landing gear strut. The indicator of *Labrecque* is operated by over-displacement of the piston. The indicator includes a rod 14 that extends through an end wall of the strut's cylinder to provide a visual indication of the quantity of oil in the strut. Thus, there is absolutely no need for a cable that passes through a wall of the strut for connecting to a probe.

Moreover, the claims have been amended further to define features not found in either *Robinson* or *Labrecque*. For this additional reason the rejection of claims 12-17 should be withdrawn.

In view of the foregoing, an early allowance of the application is earnestly solicited.

Respectfully submitted,

RENNER, OTTO, BOISSELLE & SKLAR, LLP

By Don W Bulson

Don W. Bulson, Reg. No. 28,192

1621 Euclid Avenue
Nineteenth Floor
Cleveland, Ohio 44115
(216) 621-1113